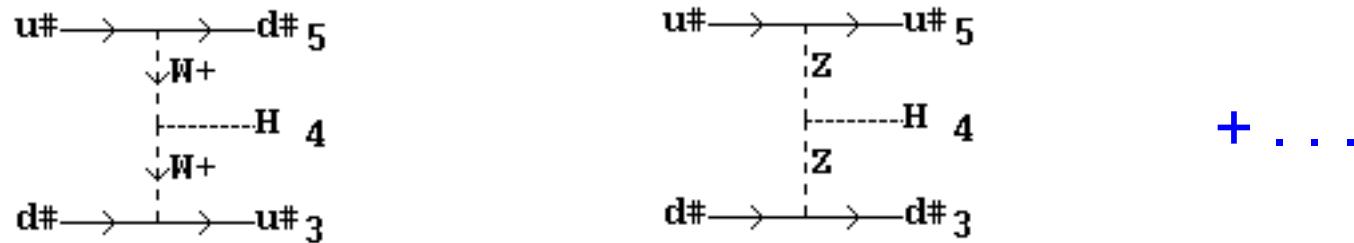


A. Nikitenko Imperial College, UK / ITEP Moscow

**Study on $qq \rightarrow qqH, H \rightarrow WW^* \rightarrow 2l$, $M_H=120$ GeV
with full cmsim/orca simulation**

**could be a discovery channel at the very beginning of
LHC running**



**check with CMS detector simulations results of
D. Zeppenfeld et al PL B 503 (2001) 113-120
obtained for light Higgs $\sim 115-120$ GeV search
(ME + smeared (ATLAS) detector)**

selections for $e \mu$ final state

- (1) $E_{T,j} > 30 \text{ GeV}$, $|\eta_j| < 5$, $p_{T,l1(2)} > 20 (10) \text{ GeV}$, $|\eta_l| < 2.4$, $\Delta R_{j,l} > 0.6$,
- (2) $\eta_{j,\min} + 0.6 < \eta_{l1,2} < \eta_{j,\max} - 0.6$, $\eta_{j1}\eta_{j2} < 0$,
- (3) $m_{jj} > 600 \text{ GeV}$, $\Delta\eta_{\text{tags}} = |\eta_{j1} - \eta_{j2}| > 4.2$
- (4) $E_{T,v} > 20 \text{ GeV}$, $\eta_{j,\min} < \eta_v < \eta_{j,\max}$ for b's from $t\bar{t}$ background
- (5) $m_{ll} > 60 \text{ GeV}$, $\phi_{ll} < 140^\circ$
- (6) veto events with $x_{\tau 1,2} > 0$, $|m_{\tau\tau} - m_Z| < 50 \text{ GeV}$
- (7-8) $50 \text{ GeV} < M_T(WW) < m_H + 20 \text{ GeV}$
- (10) $\Delta\phi(ll, p_T^{\text{miss}}) + 1.5 p_{T,H} > 180$, $\Delta\phi(ll, p_T^{\text{miss}}) + p_{T,H} > 360 \text{ GeV}$
- (4') mini jet veto $E_{T,v} > 20 \text{ GeV}$, $\eta_{j,\min} < \eta_v < \eta_{j,\max}$

bkgs, kinematics and cross-sections

QCD WWjj, QCD $\tau\tau$ jj ($p_t > 20$ GeV), tt jj - pythia 6.158 with loose selections :

- (1) $E_{T,j1,2} > 20$ GeV, $|n_{j1,2}| < 5$, $p_{T,l1,2} > 18, 8$ GeV,
- (2) $n_{j1} n_{j2} < 0$,
- (3) $m_{j1 j2} > 400$ GeV (* not for wwjj), $\Delta\eta_{tags} = |n_{j1} - n_{j2}| > 4.0$
- (5) $m_{ll} > 70$ GeV, $\phi_{ll} < 150^\circ$

EW WW jj - ME from DZ&DR interfaced with pythia (still no EW $\tau\tau$ jj) :

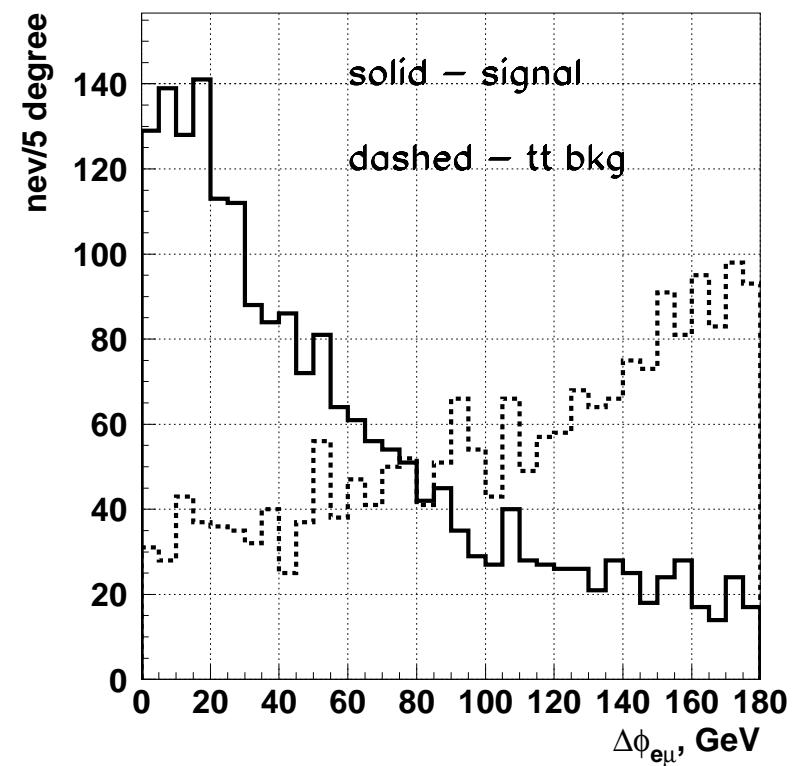
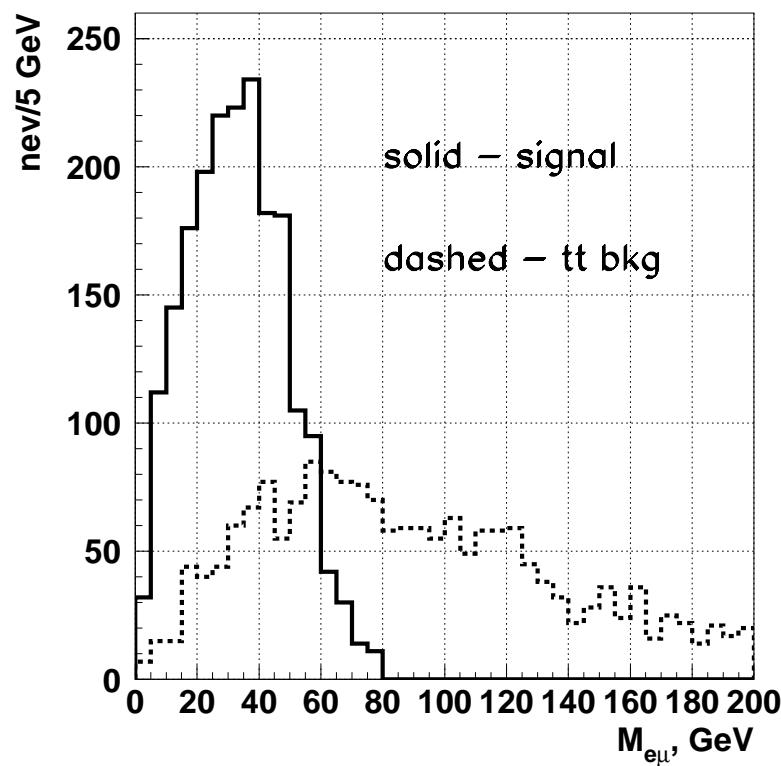
- (1) $E_{T,j1,2} > 20$ GeV, $|n_{j1,2}| < 5$

qq->qqH, $M_H = 120$ GeV with pythia 6.158

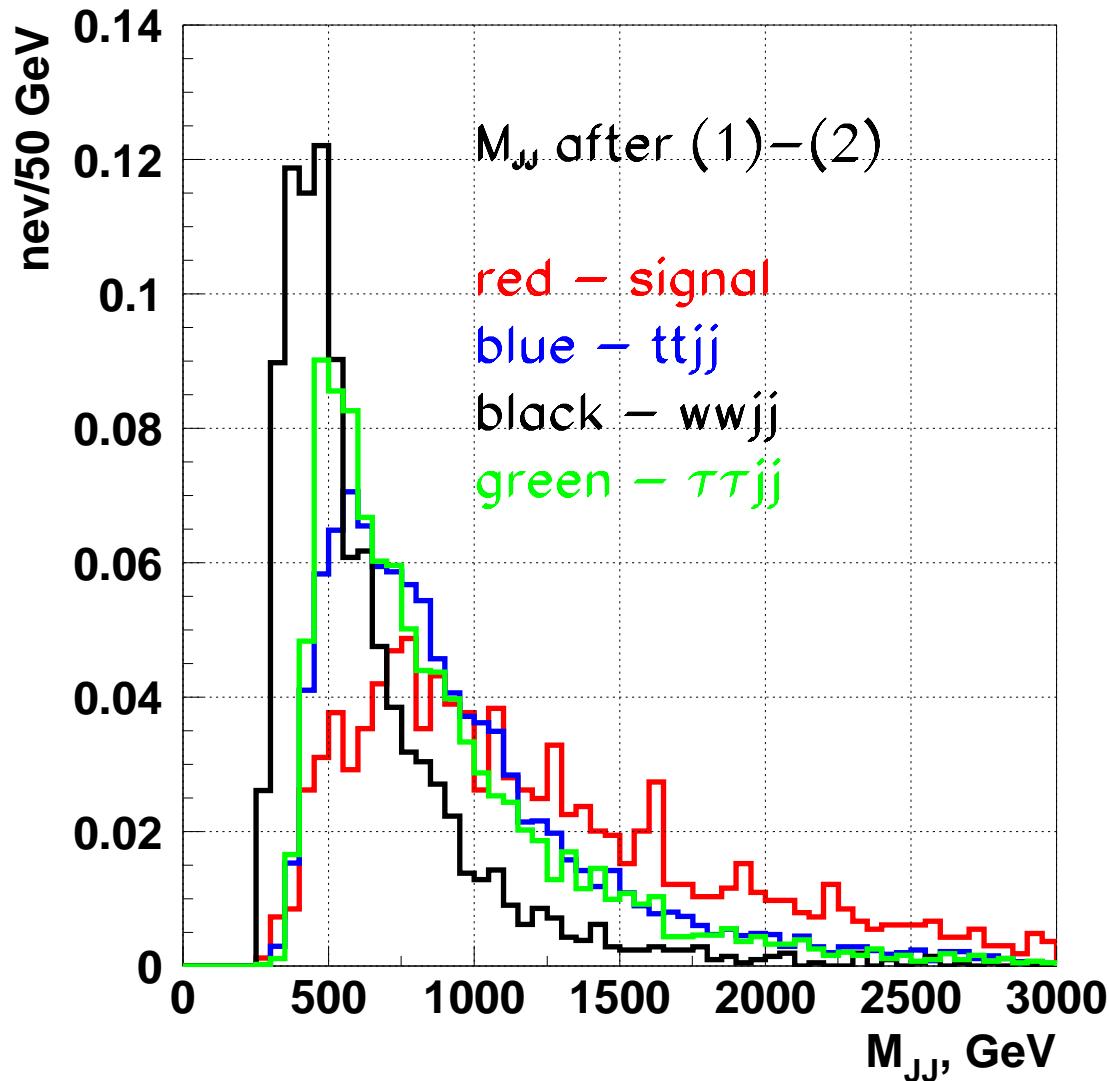
- (1) $p_{T,l1,2} > 18, 8$ GeV,

	Higgs, $M_H = 120$ GeV	QCD WW jj	QCD $\tau\tau$ jj	tt jj	EW WW jj
$\sigma \text{ Br}(e \mu), \text{fb}$	13.0	1640	42 140	18 662	32
ϵ of preselect.	0.756	1.9 e-3	2.6 e-3	8.4 e-3	1.
$\sigma \text{ Br}(e \mu) \epsilon, \text{fb}$	9.86	3.12	109.6	156.76	32

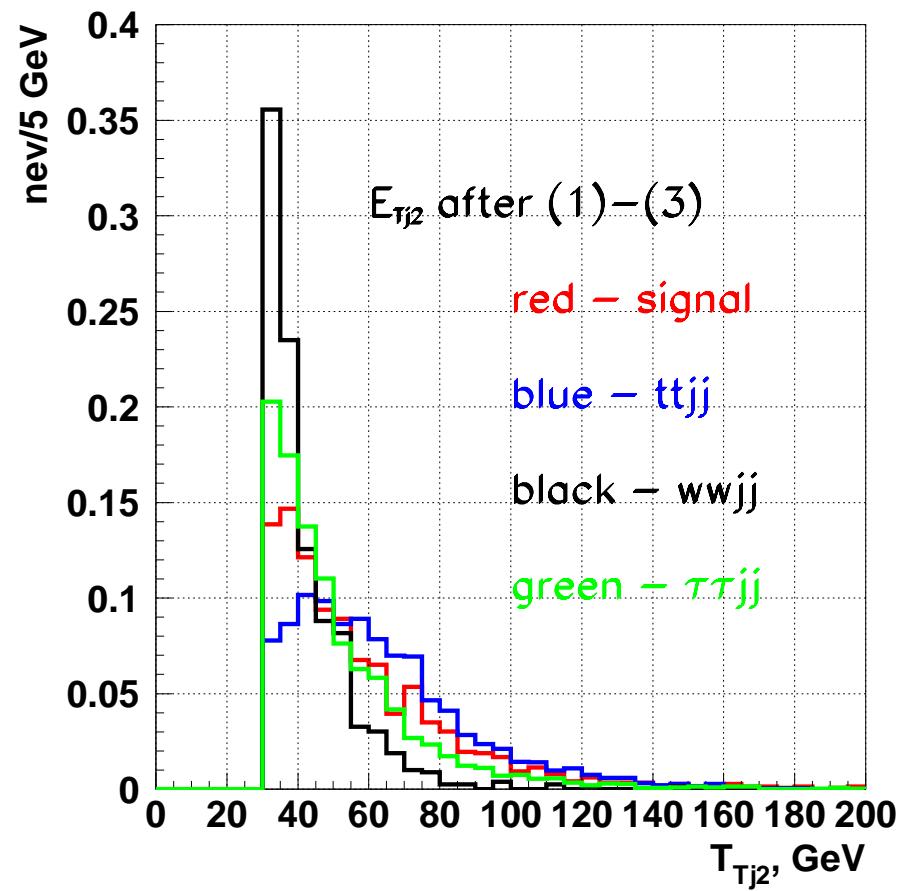
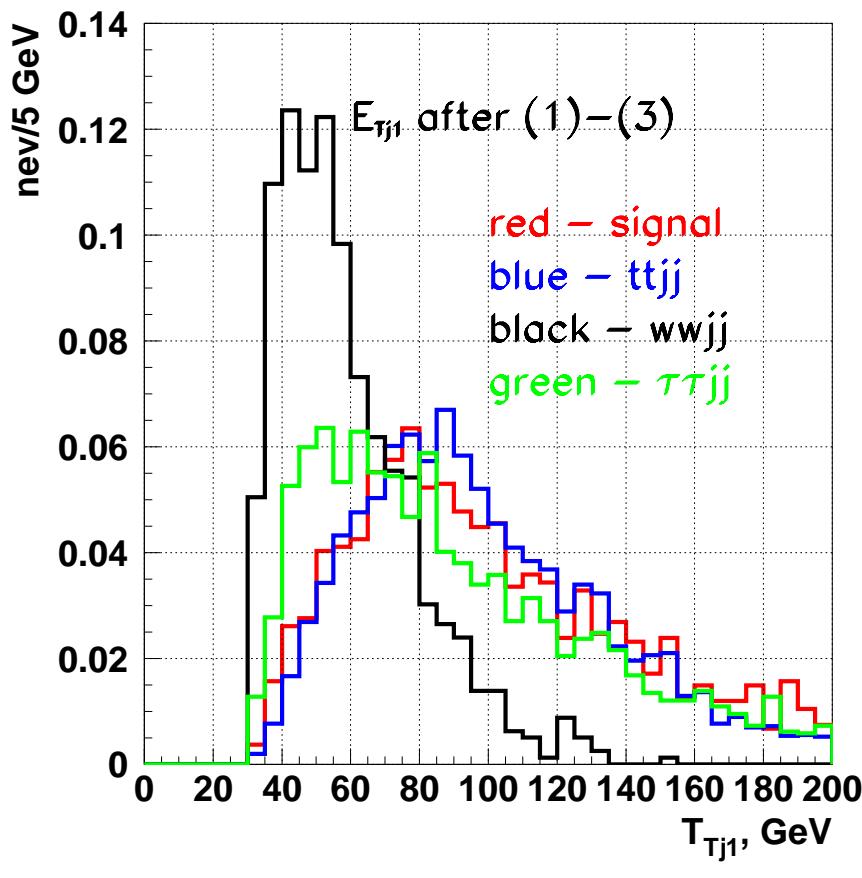
$M_{e\mu} < 60 \text{ GeV}$ and $\Delta\phi_{e\mu} < 140^\circ$ to suppress $t\bar{t} \rightarrow b\bar{b} WW \rightarrow 2l$



effective mass of two tagging jets. $M_{JJ} > 600$ GeV

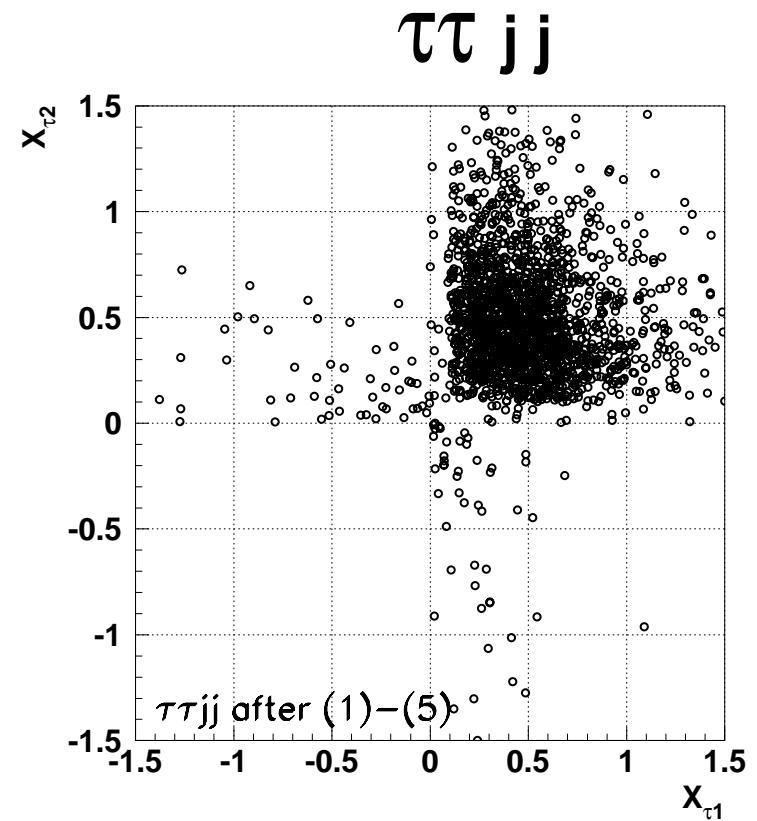
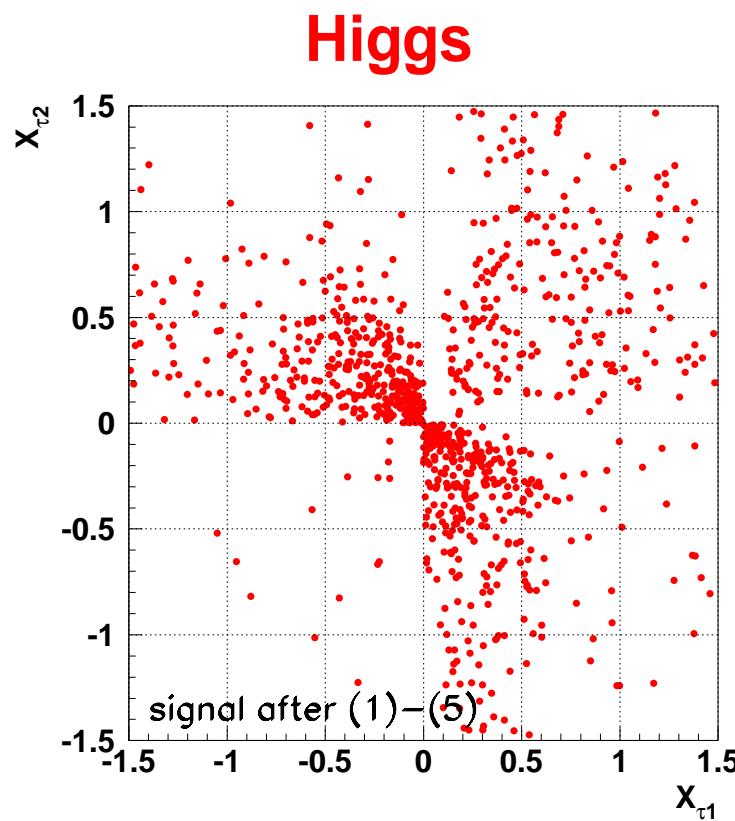


tagging jets with max. and min. E_T

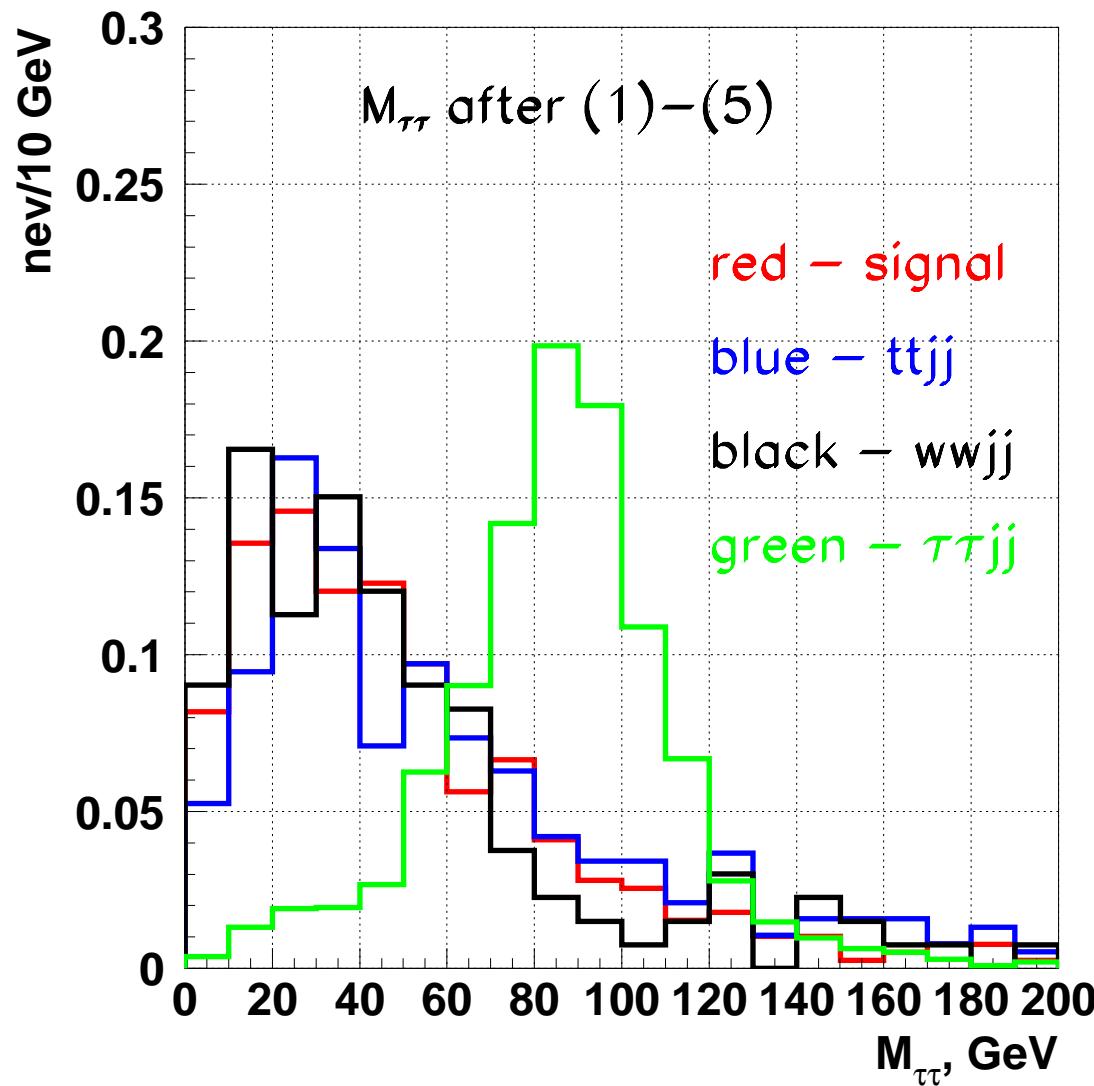


supression of $\tau\tau$ jj (I): veto events $X_{\tau 1,2} > 0$ + next slide

X_{τ} is visible τ energy



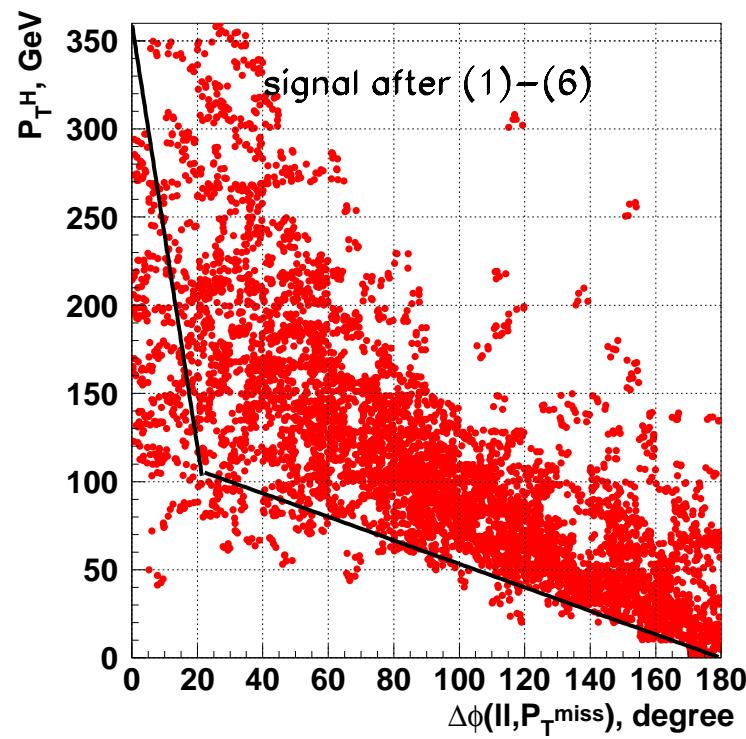
supression of $\tau\tau$ jj (II) : + $|M_{\tau\tau} - M_Z| < 50$ GeV



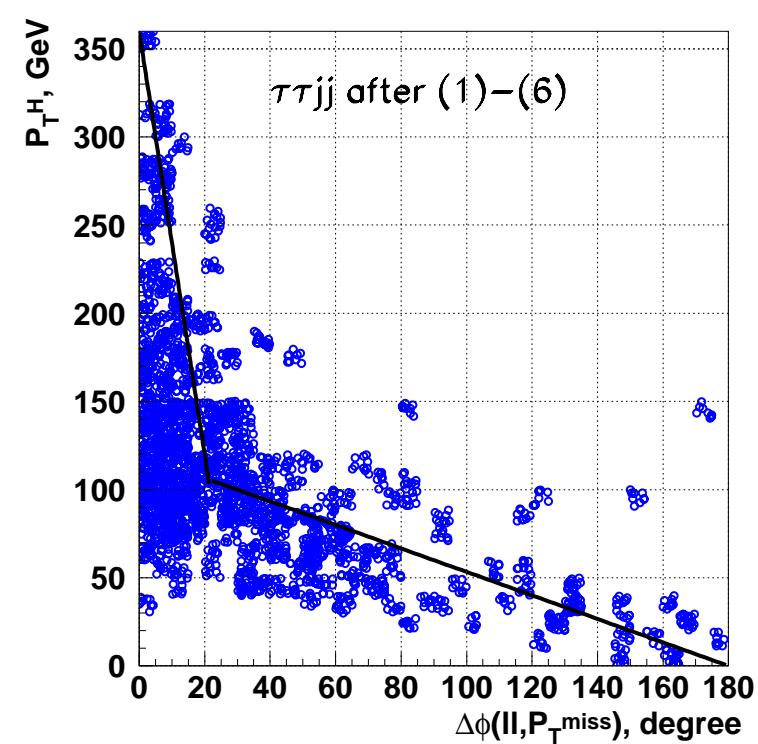
supression of $\tau\tau$ jj (III) : contour cuts

angle between miss E_T and two leptons v.s. p_T Higgs

Higgs

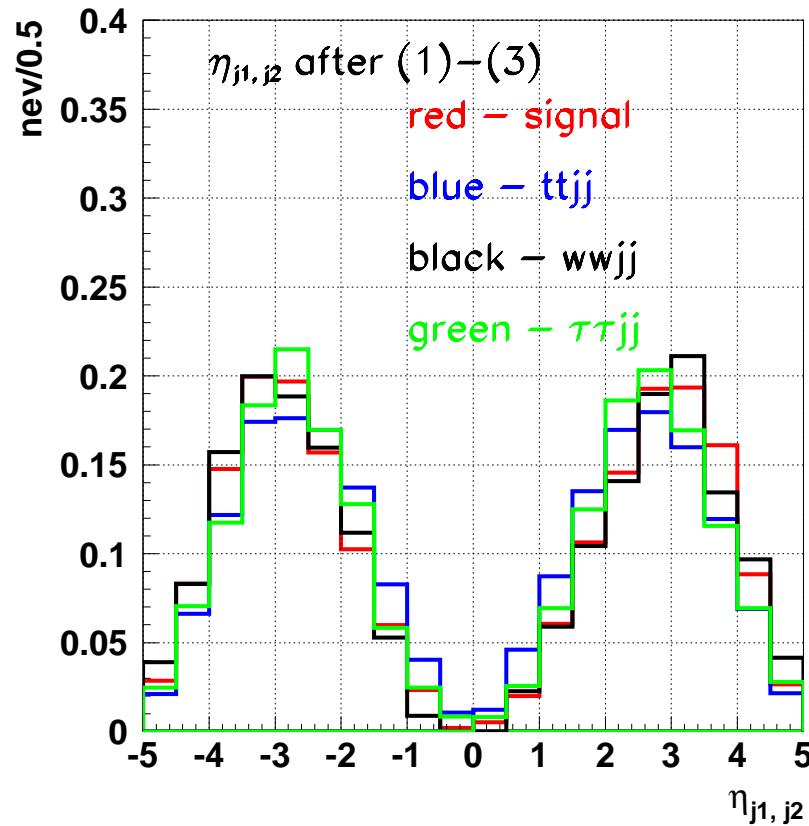


$\tau\tau$ jj



topology of tag.jets: “HF jets” $|\Delta\eta_{j_1 j_2}| > 4.2$, $\eta_{j_1} \eta_{j_2} < 0$

η_{j_1, j_2} already after these cuts

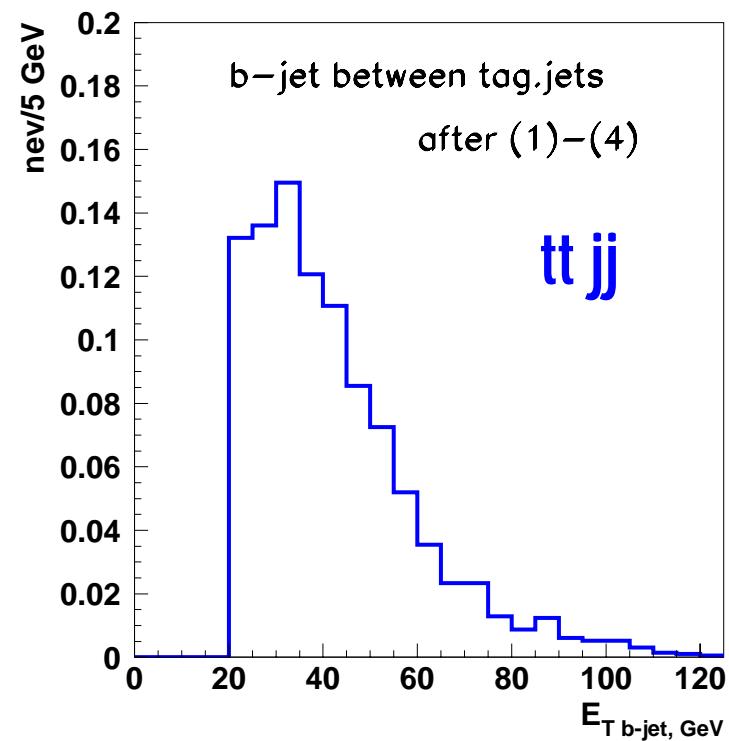
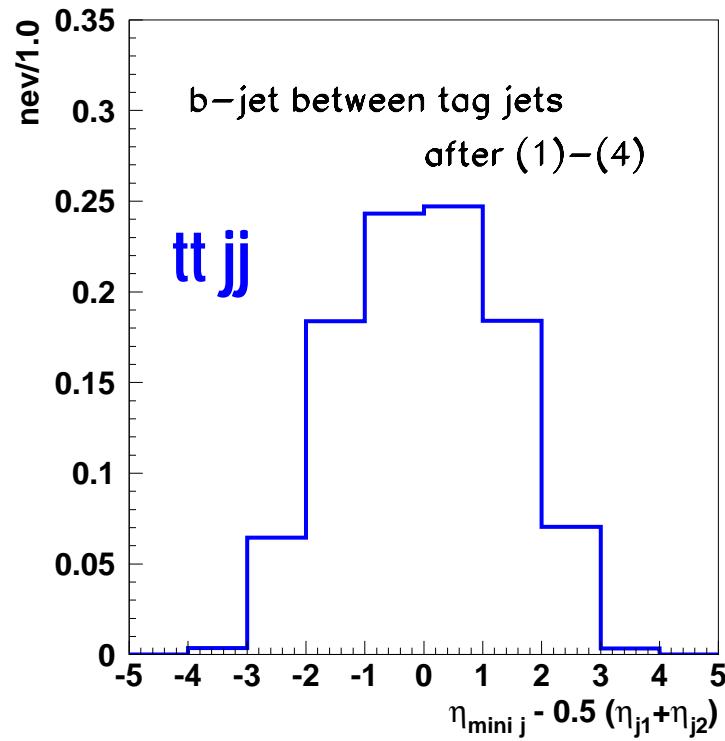


now, let's try mini jet veto between two tag. jets . . .

**Effect of mini jet veto due to b-jet(s) between two tag.jets
in tt jj bkg is separated from the effect of real mini jets**

**these two plots show b-jet found between two tag.jets
(jet $E_T > 20$ GeV with good matching with b-quark)**

b-jet(s) is found in 56 % of cases, so rejection due to b's is 0.44

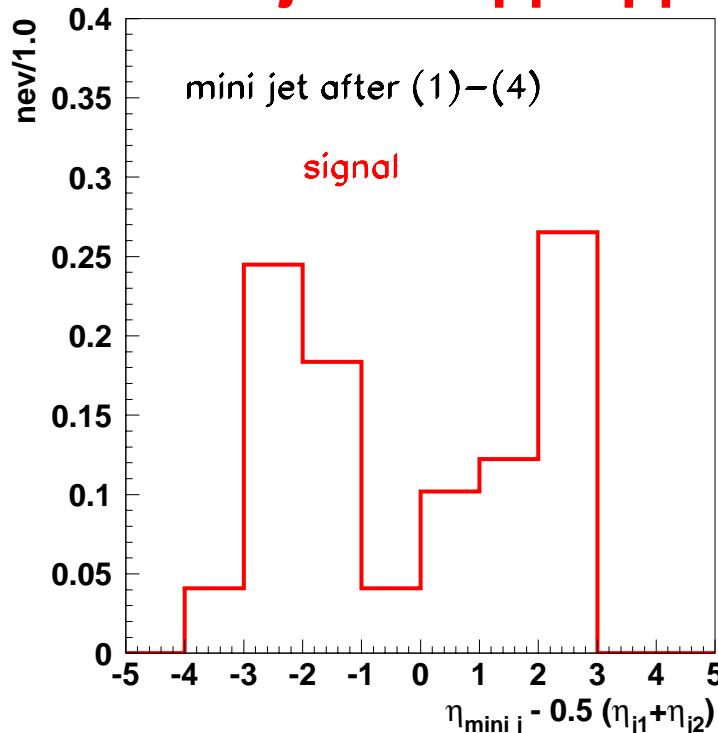


now, let's look at “real” mini jet veto due to radiation . . .

η of mini jet with $E_T > 30 \text{ GeV}$ between tag. jets

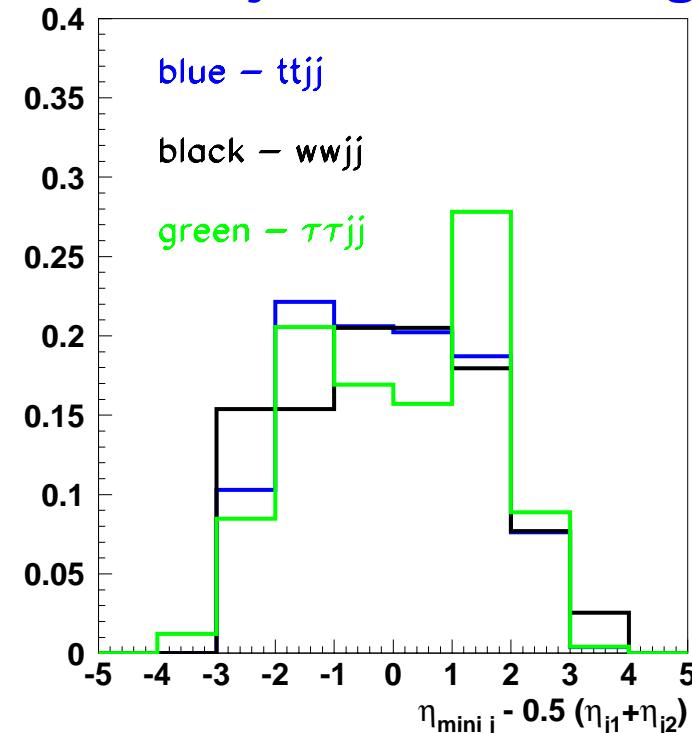
$$\eta_0 = \eta_j - 0.5 (\eta_{j1} + \eta_{j2})^*$$

mini jets in $qq \rightarrow qqH$



no color exchange between q's :
no central mini jets

mini jets in QCD bkg

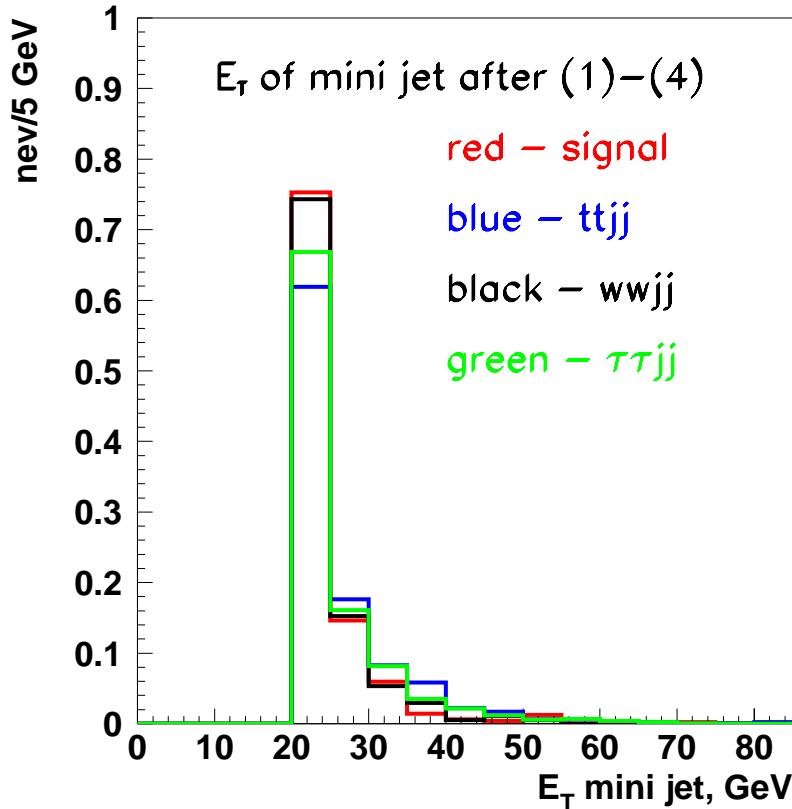


radiation in the central rapidity region for QCD backgrounds

* D. Rainwater, R. Szalapski, D. Zeppenfeld MADPH-96-943

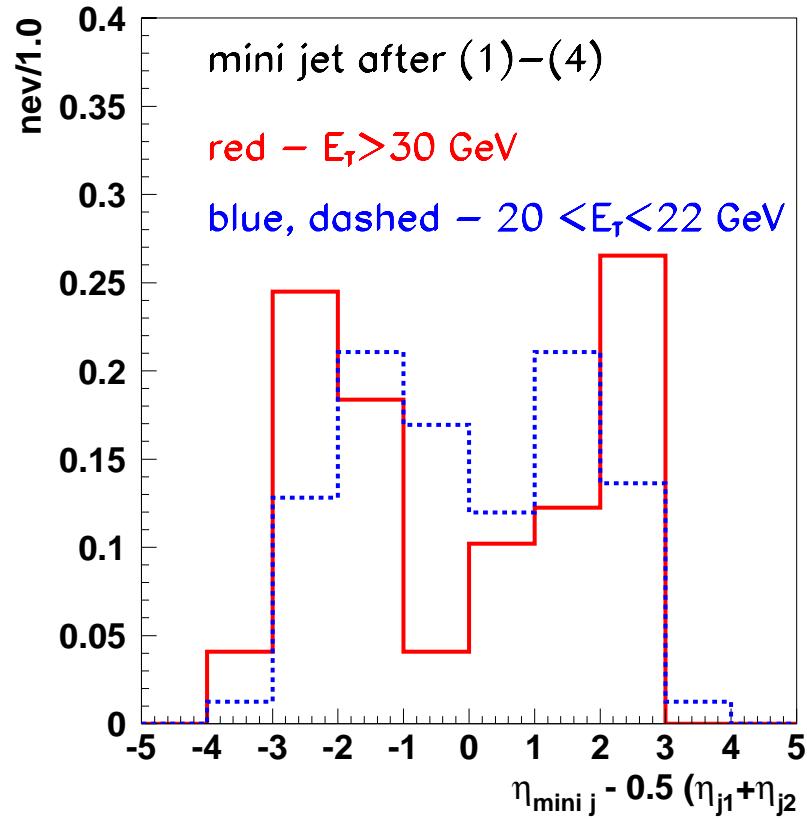
however “false” soft jets may spoil mini jet veto performance . . .

jets between tag.jets



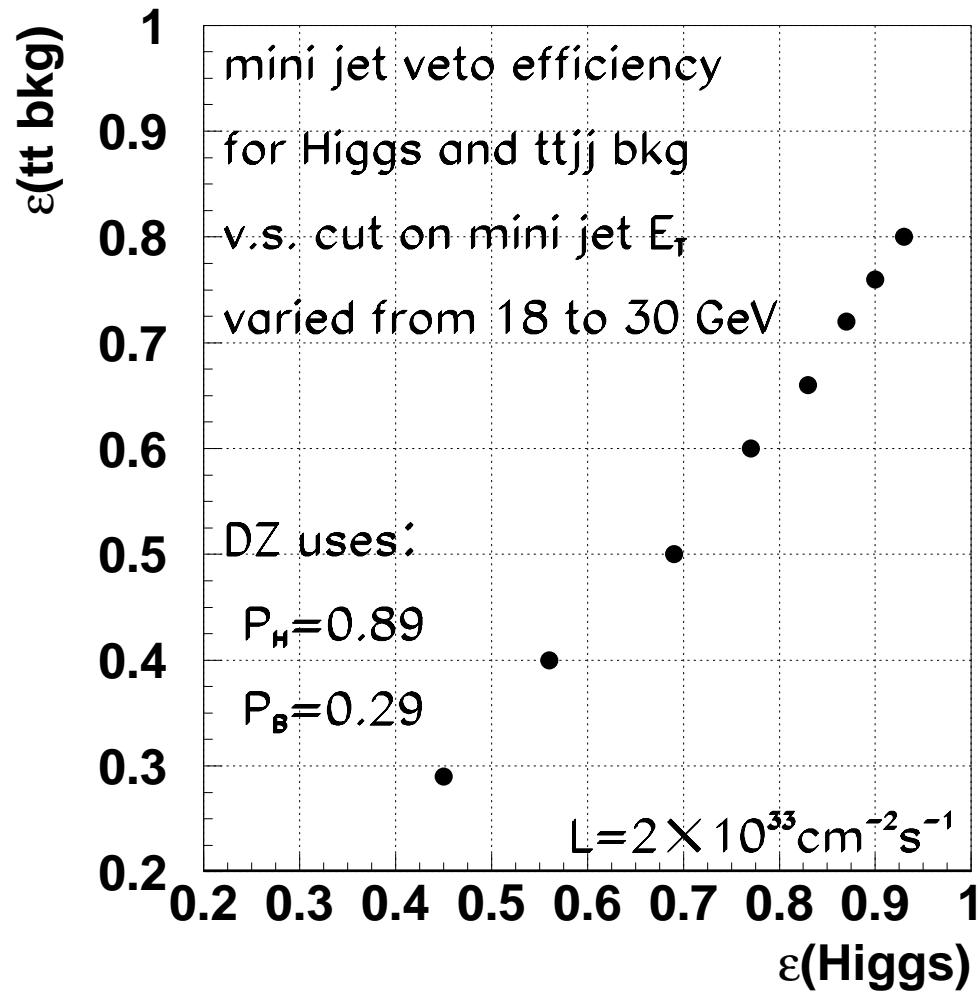
they are very soft

Higgs



very soft jets in Higgs ev.
look like in bkg . . .

efficiency of mini jet veto v.s. cut on mini jet E_T



M_T(WW) reconstruction

$$M_T(WW) = \sqrt{(E_T^{\text{miss}} + E_T^{\parallel})^2 - (P_T^{\text{miss}} + P_T^{\parallel})^2}$$

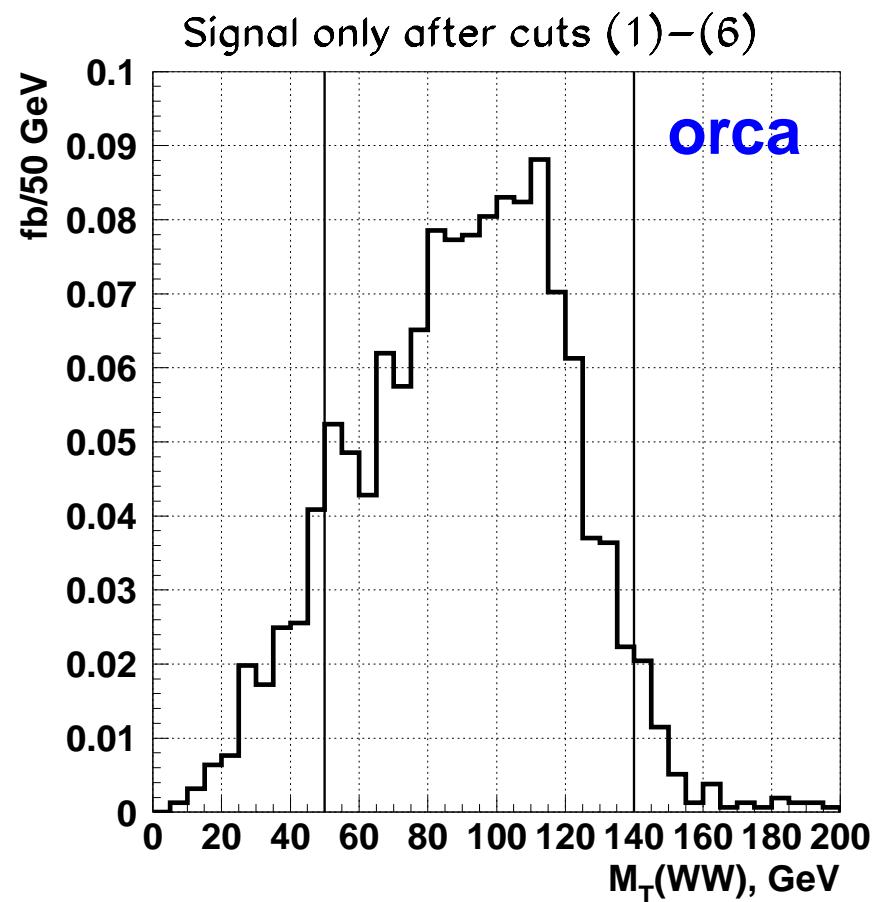
two (virtual) W's are almost at the rest in the Higgs frame =>

ℓ and ν are ~ back-to-back

$$m_{\parallel} \approx m_{vv}$$

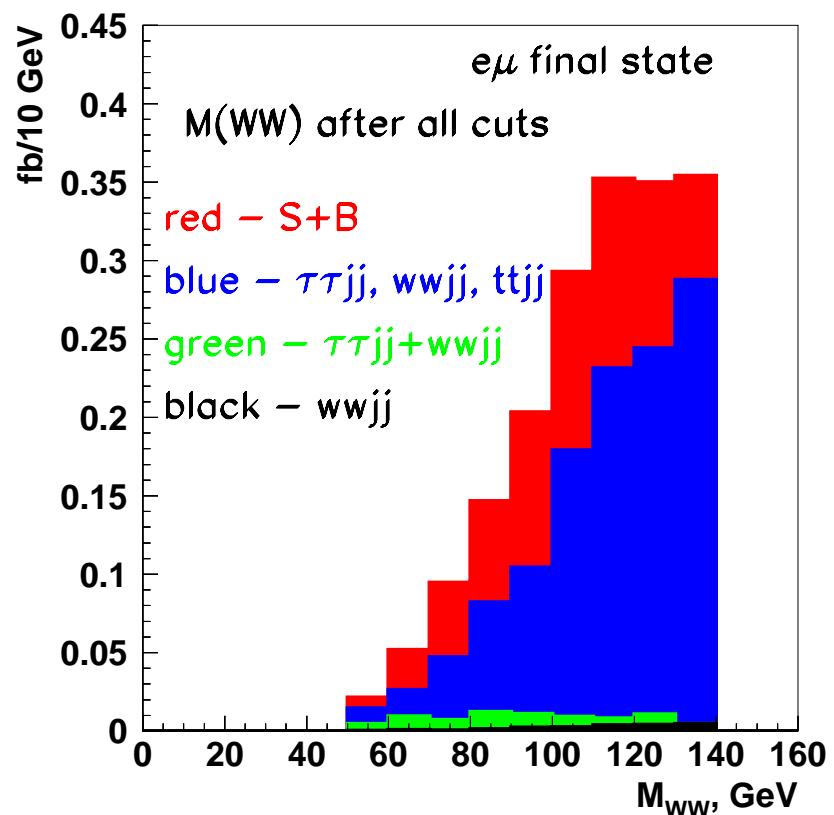
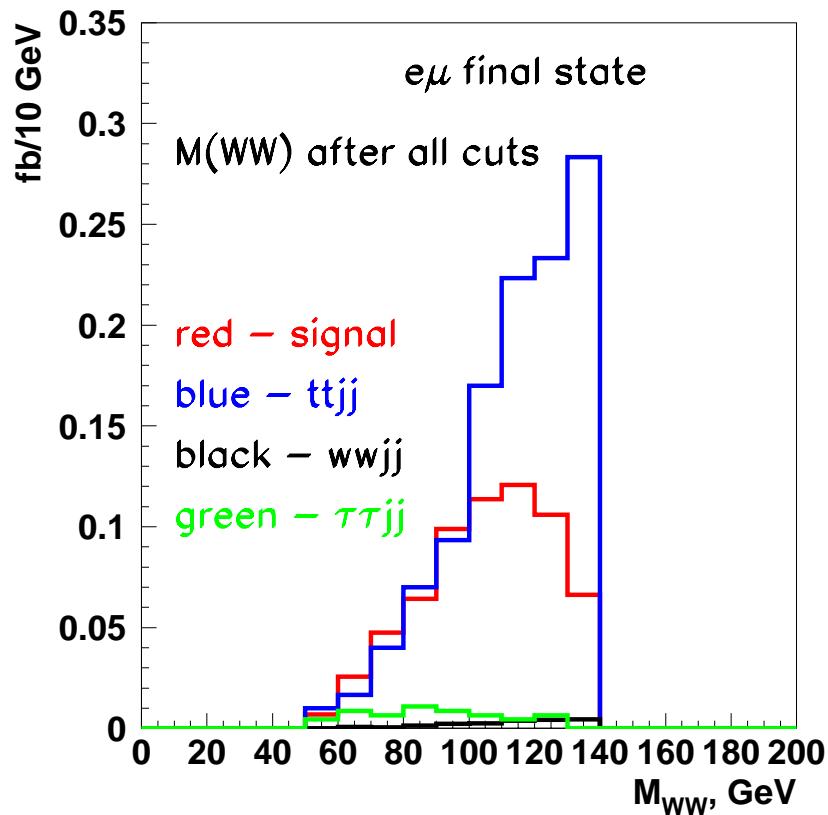
$$E_T^{\parallel} = \sqrt{(P_T^{\parallel})^2 + m_{\parallel}^2}$$

$$E_T^{\text{miss}} = \sqrt{(P_T^{\text{miss}})^2 + m_{\parallel}^2}$$



signal and bkg. after all selections

as in DZ case b-tag 60 % is used to veto tt jj events
where one (two) tagging jets are b-jets



**signal and bkg. cross sections in fb for $e\mu$ final state
numbers in parenthesis are from DZ paper**

channel	(1)- (8)	(9)	(10)	mini jet veto	b-tagging
$m_H=120 \text{ GeV}$	0.98 (1.65)	0.94 (1.48)	0.93 (1.46)	0.65 (1.32)	0.65 (1.32)
$t\bar{t}, \sigma=800 \text{ pb}$	4.20 (2.90)	3.72 (2.50)	3.68 (2.49)	1.84 (0.73)	1.14 (0.48)
QCD $ww\ jj$	0.033 (0.26)	0.028 (0.23)	0.027 (0.23)	0.015 (0.066)	0.015 (0.066)
QCD $\tau\tau\ jj$	0.521 (0.67)	0.177 (0.11)	0.172 (0.10)	0.057 (0.032)	0.057 (0.032)
EW $ww\ jj$	running				
EW $\tau\tau\ jj$					

D.Z. cross-sections for $t\bar{t}$ and $t\bar{t}j$ in (1)-(8), (9), (10), mini jet veto are taken without b-tag. $t\bar{t}\ j \times 1.6$, $t\bar{t} \times 2.3$

signal and tt jj bkg cross sections (e μ) in fb v.s. cut on mini jet E_T (after all cuts)

